TELEQUIPMENT

OPERATING INSTRUCTIONS

D 31

OPERATING INSTRUCTIONS AND MAINTENANCE MANUAL

THE NOTES CONTAINED IN THIS HANDBOOK APPLY TO MODELS D31 AND D31R. FOR THE MAIN PART THE CIRCUIT DIAGRAM AND MAINTENANCE INSTRUCTIONS ARE IDENTICAL FOR THE TWO TYPES. WHERE DIFFERENCES EXIST THIS IS MENTIONED IN THE APPROPRIATE SECTION.

C O N T E N T S

GENERAL DESCRIPTION 1

FIRST TIME OPERATION 4

MAINTENANCE AND
ADJUSTMENT PROCEDURES 15

COMPONENT LISTS 20

TUBES 28

VOLTAGE TABLES 29

TUBE CHANGING DATA 30

CIRCUIT DIAGRAMS 31

GENERAL DESCRIPTION

CATHODE RAY TUBE

This is a new $3\frac{1}{2}$" flat faced tube having two identical gun and deflection assemblies. The top gun is usable over the top 5 cm of the 6 cm graticule and the bottom gun over the bottom 5 cm giving a 4 cm overlap.

Separate brightness and focus controls are provided for the two traces with a common astigmatism control. The P1 phosphor is normally supplied but a long persistence (P7) tube is available if specified. A green or amber filter is provided to improve the contrast under conditions of high ambient illumination. Internal pre-set controls are provided for horizontal alignment of the two traces and equalisation of the deflection sensitivities of the two guns.

VERTICAL DEFLECTION AMPLIFIERS

Two identical amplifiers are provided, one driving the vertical deflector plates of the upper gun and the other driving the vertical deflector plates of the lower gun.

Each amplifier is a four-stage, balanced, D.C. coupled circuit, compensated for optimum pulse response, and has a band-pass of approximately 6 Mc/s (-3dB). The rise time is approximately .06usec.

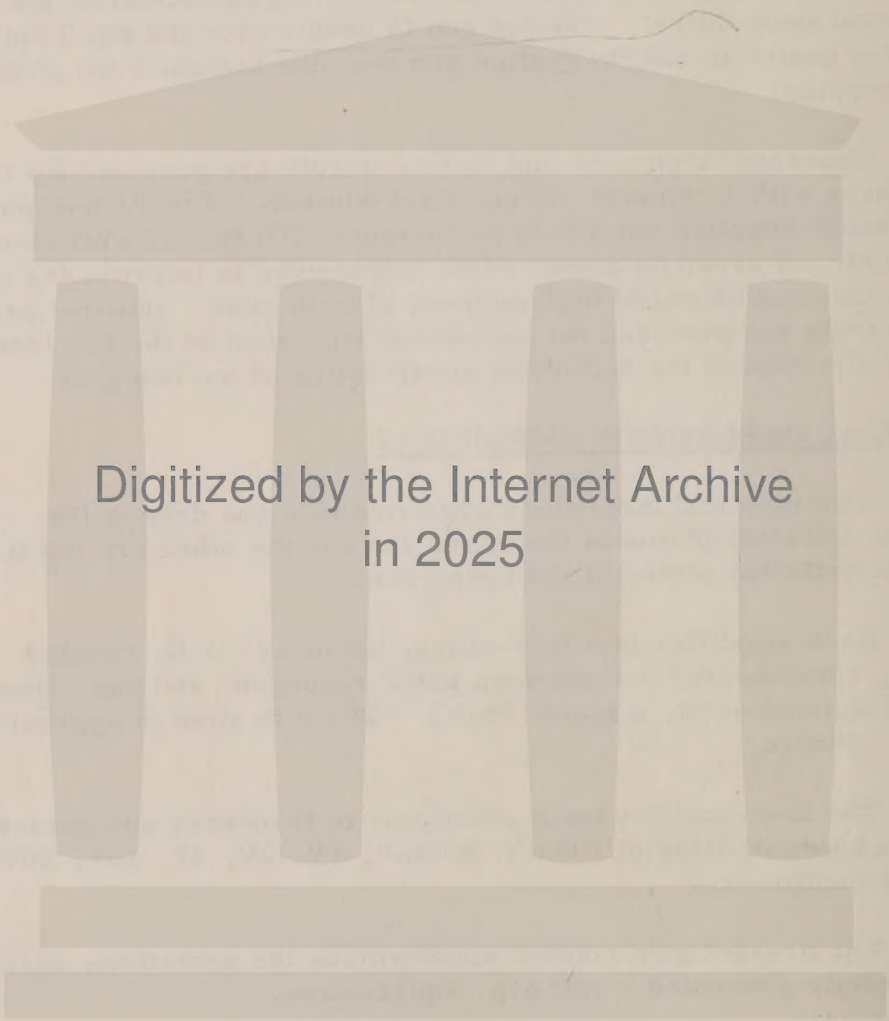
The nine-position input attenuator is frequency compensated and gives sensitivities of 100mV, 500mV, 1V, 2V, 5V, 10V, 20V & 50V per centimetre.

The pre-set gain control standardises the sensitivity against an internally generated 1 volt p.p. squarewave.

The input impedance is 1 Megohm, shunted by about 30 pf.

VOLTAGE CALIBRATOR

A 1 volt p.p. squarewave, stabilised against line voltage variations is available at a connector on the front panel.


Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_08713

SWEEP CIRCUIT

The sweep generator is a Miller run-down circuit giving excellent linearity. Eighteen pre-set sweep speeds are provided, from 1 usec. per cm. down to .5 sec. per cm. in 1, 2, 5, 10 etc. multiples. A variable control with a range of approximately 3:1, allows adjustment of sweep speed between ranges.

HORIZONTAL AMPLIFIER

The X-GAIN control expands the trace to over 10 diameters and sufficient shift is provided to enable any part of the expanded trace to be positioned centrally on the screen.

TRACE UNBLANKING

D.C. Coupling of the unblanking waveform gives uniform trace brightness at all sweep speeds.

TRIGGERING

Two modes of triggering are provided:

1. AUTO. On this setting the sweep free runs at a slow speed in the absence of an input signal, but will be triggered automatically as soon as an input signal is applied. This mode of operation can be used for 90% of all normal laboratory uses.

2. TRIGGER LEVEL SELECTION. With the AUTO switch OFF the Trigger Level Control allows the sweep to be triggered at any point on the input waveform.

T.V. SYNC SEPARATOR

The built-in TV sync separator triggers the sweep from the Line or Frame pulses of a composite Television waveform.

REAR CONNECTORS (D31R)

Connectors on the rear panel provide access to the Horizontal Amplifier, intensity modulation of the beam and the sweep output waveform.

REAR CONNECTORS (D31R) (continued)

In addition to the horizontal input, sweep output and "Z" modulation connectors, two additional coaxial sockets are provided so that the inputs to the two amplifiers may be applied to the back of the instrument where this is more convenient. These sockets are normally left unwired in order to keep the input capacity down to a minimum. Where it is required to use these connectors they should be joined in parallel with the front sockets with a short length of low capacity screened cable. This will add a further 10 pf or so to the input capacity.

PROBE TEST POINT

A test point is provided on the front panel giving a suitable step voltage for adjustment of the high impedance probes.

COOLING

The D31 is cooled by convection. Air enters the bottom of the case and is drawn up past the tubes and other hot components which are all located on the left hand side of the chassis, passing out through the slots at the top. Do not obstruct the air flow in any way. Do not put anything on top of the instrument and make sure that there is an air space underneath.

The D31R will operate perfectly satisfactorily in a rack provided that there is a reasonable air flow and the instrument is not located immediately above other heat generating equipment. If the ambient temperature inside the rack is excessive, a small cooling fan can be fitted on to the back of the D31R chassis. Holes are provided for mounting this fan, which is available as an extra if specified.

FIRST TIME OPERATION

Unless you are familiar with this type of sweep generator follow these simple instructions carefully and then run through the procedure a few times to feel thoroughly at home with the instrument before putting it into use.

Set the front panel controls as follows :

INPUT SWITCH	D. C.
VOLTS/CM	.5
FOCUS	Mid position
ASTIG	Mid position
Y SHIFT	Mid position
BRILLIANCE	Fully anti-clockwise
X GAIN	Fully anti-clockwise
X SHIFT	Mid position
STABILITY	Fully clockwise
TRIGGER LEVEL	Anti-clockwise to position just before switch operates.
TIME/CM	20 ms
VARIABLE	Fully clockwise
TRIG SELECTOR	+ ve

Switch on and allow a few minutes for the instrument to warm up. Now advance the brilliance control until a trace appears and position the trace in the centre of the screen by means of the X and Y SHIFT controls. Adjust the ASTIG and FOCUS controls for a clean sharp trace.

Repeat for the other trace.

Now back off the STABILITY control until the sweep just fails to free run. This is the normal position of the STABILITY control and once it is set it should not require any readjustment except at the very highest sweep speeds. The instrument is now ready for use.

You will find that if the TRIGGER LEVEL control is turned fully anti-clockwise to operate the AUTO switch, the trace will re-appear. In this condition the instrument is ready to accept almost

any input waveform and trigger automatically from it, the only adjustments required are the selection of the appropriate sweep speed and Y Sensitivity (VOLTS/CM). However, in order to use the D31 to best advantage the functions of the controls should be understood fully and the following procedure will demonstrate their use.

Return the TRIG LEVEL control to the position just before the Switch operates. There should now be no traces visible on the screen (there may be a bright spot at the left-hand side of the screen depending on the precise setting of the BRILLIANCE controls).

Now join a short connector between the CAL. post and the INPUT sockets and rotate the TRIG. LEVEL control clockwise until the traces appear. (If the sweep does not trigger it is because the STABILITY control has been backed off too far). The Scope is now displaying the calibration voltage waveform which should be a square wave of 2 cm. amplitude with one cycle occurring every cm. You will find that this is a very convenient waveform for demonstrating the functions of the controls.

FOCUS AND ASTIG

You will find that by adjusting the FOCUS controls either the horizontal or vertical edges of the squarewave can be brought into focus, but only if the ASTIG. control is in the correct position will it be possible to focus the whole of the waveform simultaneously. Once the ASTIG. control is set it should require no further adjustment and a clean fine trace will be obtained over the whole of the screen.

SWEEP CONTROLS

TIME/CM

The calibration waveform is at supply line frequency so that when operating at 50 c/s, 1 cycle occupies 20 milliseconds. With the TIME/CM switch set to 20 milliseconds per cm. the SET SPEED control can be adjusted so that one cycle of the calibration waveform occupies precisely 1 cm. This standardises the whole of the time calibration of the instrument, all other ranges being direct multiples of this. Speed calibrations only apply when the VARIABLE control is in its fully clockwise position.

For most purposes, however, when time calibration is not required, the TIME/CM and VARIABLE controls are merely used to obtain a picture of convenient size.

In the case of instruments intended for use on 60 cycle supplies :

D31R The calibrated position of the VARIABLE control is in the fully anti-clockwise position just before the switch operates. In order to calibrate the instrument it is necessary to rotate the VARIABLE control still further to operate the switch and set the TIME/CM to 10 milliseconds. In this position the sweep speed is 16.6 milliseconds per cm., i.e., 1/60 second.

D31 Press switch to calibrate on 10 milliseconds VARIABLE fully clockwise.

TRIG LEVEL

Set the TIME/CM switch to 5 ms./cm. giving 1 cycle of the squarewave 4 cm. long. Now rotate the TRIG. LEVEL control and it will be found that the starting point of the trace can be moved up and down the sloping edge of the squarewave. If the control is turned too far clockwise the trigger point goes over the top of the squarewave and the sweep stops. Similarly, rotation too far anti-clockwise sets the point too low and the sweep again stops. It should now be appreciated that this control does not govern the amplitude of the trigger signal but sets the precise point or level at which the sweep triggers. Thus by adjusting this control, the sweep can be made to trigger at any point on the input waveform. (Positive or negative edges can be selected on the TRIG. SELECTOR SWITCH). This facility is extremely useful when dealing with complex waveforms when a normal type of sweep generator will either not trigger at all or will double trigger and produce a multiple pattern. It is also useful as an amplitude discriminator enabling the sweep to ignore small amplitude signals and only trigger when the input voltage reaches a pre-determined value. You will find that adjusting the sweep speed does not alter the trigger point, the trace simply expands from the given starting point. This will enable you to examine a section of the waveform in detail by setting the TRIG. LEVEL control to trigger just before the portion to be examined and expanding this portion as required by the sweep speed controls.

AUTO

On this setting no control over the trigger level is available. The sweep automatically adjusts itself to trigger at approximately the mean level of the input waveform. You can use this setting for practically all applications involving repetitive waveforms of a fairly simple nature and the sweep generator will trigger automatically on signals between about 50 c/s and 1 Mc/s, provided the amplitude exceeds about 2 mm.

In the AUTO position with no input signal the trace will become progressively less bright as the sweep speed is increased. This is normal since in the absence of a trigger signal the sweep free runs at about 50 c/s whatever the setting of the speed control. As soon as an input signal is applied the sweep will immediately synchronise to it and the trace will revert to its full brightness.

TRIG SELECTOR (D31R)

There are two trig selector switches on the D31R, one selects the triggering signal source, i.e. from Y1 (upper trace), Y2 (lower trace) or external (connector on front panel). The other switch has six positions. For most purposes use the positive or negative normal positions depending on the polarity of the input waveform.

The other four positions bring the internal Sync. Separator into circuit for use on TV waveforms enabling the sweep to be triggered from the Line or Frame pulses independent of the picture content (the +ve TV positions refer to positive-going video signals, i.e. picture + ve sync. - ve). When triggering from a TV frame pulse, adjustment of the TRIG. LEVEL control will determine which of the broad pulses actually triggers the sweep.

The Sync. Separator includes an integrating circuit for the frame pulse and this can be useful on occasions for frequency discrimination. For instance an audio signal containing a large proportion of HF noise will trigger better on the TV frame position, the integrator acting as a low pass filter.

TRIG. SELECTOR (D31)

The D31 has three selector switches, one selecting the signal source as in the D31R. Of the other two, one selects positive or negative polarity and the other normal operation TV line or TV frame.

X-GAIN AND X-SHIFT

With the X-GAIN control in the minimum (anti-clockwise) position, the trace will be approximately 7 cm. long and the X-SHIFT control should be used to centre this trace about the 6 cm. ruled graticule. Increasing the X-GAIN control expands the trace about the centre of the screen up to a maximum of just over 10 screen diameters giving an effective trace length of 60 cm. and the X-SHIFT control is then used to position the required portion of this trace on the screen.

It should be noted that the time calibration only holds good at the minimum setting of the X-GAIN control. If you want to measure time intervals at any other setting the speed must be standardised at this setting by means of the internal calibration waveform. For instance, if the X-GAIN control is increased so that 1 cycle of the calibration waveform occupies 5 cm. then the gain is exactly five times on all ranges, and provided the X-GAIN control is not touched all sweep speeds will be multiplied by a factor of 5. Obviously you can have any multiplication factor between 1 and 10.

VOLTS PER CM.

This is a nine-position switch which inserts a series of frequency compensated resistance dividers between the input socket and the Vertical Amplifier. Normally this is used merely to obtain a picture of convenient height, but if the gain of the Amplifier is standardised, direct readings of input voltage can be made. For this purpose the calibration voltage waveform should be set by means of the SET Y-GAIN pre-set control so that the 1 volt squarewave occupies exactly 2 cm. on the .5v/cm scale. The squarewave amplitude should be measured between the flat patterns. All other ranges are then direct reading in volts per cm.

D.C./A.C. SWITCH

On the A.C. position this switch inserts a blocking capacitor in series with the input of the Vertical Amplifier removing the D.C. component of the signal. This is the condition in which the D31 will normally be used unless it is specifically required to include the D.C. component or to use the instrument on very low frequency signals. The time constant of the input circuit on the A.C. position is such that the response is 3dB down at 2 cycles, which, while adequate for all normal purposes, may limit the application in some instances. For instance you will notice that on the 50 cycle square-wave a pronounced tilt occurs on the A.C. position. If a longer time constant is required, a higher capacity external blocking capacitor must be used with the input switch set to D.C.

REAR CONNECTORS

1. Sweep output. A negative going saw-tooth waveform of approximately 25 volts amplitude is available at this connector and can be used for instance, to drive an external circuit. This socket is D.C. coupled to preserve the shape of the waveform at the lowest sweep speeds and in some instances a blocking condenser may have to be used. The output waveform is only linear when the X-GAIN control is set to the minimum position. At all other settings of the X-GAIN control only the portion of the saw-tooth which is actually on the screen is linear. When using this waveform as a drive for an external circuit it will usually be necessary to turn the STABILITY control clockwise until the sweep free-runs.

2. X-AMP input. This socket provides an access to the input of the Horizontal Deflection Amplifier and is suitable for signals between about 1 and 25 volts p.p. The X-GAIN control gives about a 10 to 1 variation of gain. When using the X-Amplifier the sweep can be stopped by turning the STABILITY control fully anti-clockwise. The input impedance is about 500K and the input capacity about 100pf. The frequency response is 3 dB down at 5 cycles and at about 400 K.C.s.

In the above instructions the functions of controls have been explained in some detail so that the engineer using the D31/D31R may fully appreciate its capacities and the method of function. There

REAR CONNECTORS (continued)

will, however, be a large number of users who will not require all the facilities provided and to whom simplicity of operation is of major importance. The following simplified instructions will suffice for most applications, in fact for any application where the older type of Oscilloscope could be used the following method will provide much better results much more quickly and simply.

Set input switch to A.C.

Switch on and allow a few minutes to warm up.

Turn STABILITY control fully clockwise and adjust BRILLIANCE and FOCUS controls for a sharp trace.

Back off STABILITY control until the TIME BASE stops. The STABILITY control once set should not require any further adjustment.

The instrument is now set for use.

For most applications switch to AUTO, connect input signal and adjust VOLTS/CM. switch to give a convenient size trace. Use TIME/CM and VARIABLE as course and fine frequency controls to suit the input signal.

For TV waveform use L or F positions of TRIG. SELECTOR. If the sweep fails to lock, the STABILITY control has been turned up too far.

For some input waveforms and sometimes for TV waveforms it may be necessary to adjust the TRIG. LEVEL control rather than to use the AUTO position.

CIRCUIT DESCRIPTION

INPUT ATTENUATOR

The input capacitor C.1. is normally in series with the input to the Attenuator but is shorted by S.1. in the D.C. position. The input Attenuator has four frequency compensated resistance dividers and these are used singly or in cascade giving nine division ratios. The first section has ratios of 1, 10 and 100, and the second section 1, 2 and 5.

VERTICAL AMPLIFIER

The Vertical Amplifier uses four identical triode pentode tubes. In each case the pentode section is used as the Amplifier and the triode section as a cathode follower. V1a and V2a form a cathode coupled pair with R16 as the common cathode resistor, L1 and L2 are peaking inductances. R19 is the vertical positioning control and adjusts the potentials at the plates of V1a and V2a. V1b and V2b are cathode followers driving input Amplifiers V3a and V4a. The cathodes of V3a and V4a are connected via R28, which is the set GAIN control and the frequency compensating network R29 and C17. Inductances L3 and L4 are included in the plate circuits of V3a and V4a and are adjustable for high frequency peaking. V3b and V4b are cathode followers feeding the vertical deflector plates through networks L5 and R42, L6 and R43. The signal at the cathode of V3b is taken via R41 to the internal position of the TRIGGER SELECTOR switch. The plate and screen supplied for V1a and V2a are taken from a common resistor R40 included in the cathode circuits of V3b and V4b, so that the cathode current of the input stages flows through the two output cathode followers; this is done to reduce the total current consumption of the Amplifier and to provide a measure of stabilisation so that the overall gain of the Vertical Amplifier is proportional to the power supply voltage.

TRIGGER CIRCUIT AND SYNC. SEPARATOR

The TRIG. Selector Switch S3 has three sections. The first selects either internal or external triggering. The second the positive or negative output of the phase splitter V5b and the third

section either the output of the phase splitter direct or the output of the T.V. Sync. Separator V5a. V5b is a conventional phase splitter an in-phase signal appearing at its cathode and an out of phase signal at its plate. The T.V. Sync. Separator V5a accepts a negative going input waveform, i.e. Sync pulses positive, and provides negative going Sync. pulses at its plate. The integrating circuit R52. C22 effectively removes the line pulses leaving only the frame pulses. From the phase splitter or from the Sync. Separator the triggering signal is injected into the grid of V6a. V6a and V6b form a conventional cathode coupled bistable switch, the switching level being adjusted by the potential at the grid of V6a. The grid resistor of V6b and R63 is adjusted to give maximum sensitivity consistant with reliable triggering. On the AUTO position the switch S4 is opened and the grid of V6a is returned to the grid of V6b. In the absence of a signal V6 oscillates at a frequency determined by the time constant of R58 and C24 but as soon as any input signal between about 50 cycles and 2 Mc/s is applied to the grid of V6a this self oscillation ceases and the grid of V6a assumes the same potential as the grid of V6b. The squarewave at the plate of V6b is differentiated and used to trigger the time base.

TIME BASE AND HORIZONTAL AMPLIFIER

V7a is the Miller Sweep Generator, the speed of run-down being controlled by Ca and Ra. Ra is switched to provide the MULTIPLIER and Ca is switched by the time per cm. switch. R66 determines the potential to which the charging resistor Ra is returned and is used to set the Sweep speeds. The Miller valve is keyed by V8b which together with V9b form a D.C. coupled multivibrator. In the rest position V8b is conducting and V9b is cut-off, its plate being clamped to 250v by the diode V7b. When a negative trigger pulse is applied to the cathode on V7b it momentarily lowers the grid potential V8b. The resulting rise in plate potential V8b is coupled to the grid of V9b via R76 and C b, this in turn lowers the plate voltage of V9b still further and the regenerative action V8b going to cut off and V9b conducting. When the rundown has reached the point where the cathode of V8b is at a lower potential than the plate of V9b, V8b again starts to conduct and a negative pulse is applied to the grid of V9b, regeneration again takes place driving V9b to cut-off and V8b conducting. The STABILITY CONTROL R79 sets the grid potential of V9b to the point just short of the free

running condition. The linear sweep voltage at the plate of V7a is taken via the network R74 C27 and applied to the grid of the Horizontal Amplifier comprising V8a and V9a. R83 and R82 form the grid resistor of V8a and R83 is made variable to set the trace length at the minimum GAIN position. The Horizontal SHIFT voltage across R85 is applied in series with the sweep voltage to the grid of V8a. The GAIN of the Horizontal Amplifier is varied by the resistor R92 connecting these two cathodes V8a and V9a. The grid potential of V9a is adjusted by the resistor R98 so that the trace is in the centre of the screen with the Horizontal SHIFT control in its mid position. Outputs from the plates of V8a and V9a are taken to the deflector plates of the cathode ray tube. An external signal can be applied to the grid of V8a via the capacitor C29 from the connector at the rear of the instrument. In this condition the sweep generator can be stopped by backing off the STABILITY control. The sweep voltage at the cathode of V8a is taken to another connector on the rear of the instrument and can be used to drive an external circuit.

VOLTAGE CALIBRATOR

A two stage clipper circuit using three neon diodes N1 N2 N3 is used to generate a squarewave of stable peak to peak amplitude. The AC line frequency voltage across the secondary of the power transformer is taken via R114 to the first stage of clipping comprising N1 and N2 in series, across these two tubes appears an approximately squarewave of 200 volts peak to peak amplitude, this is applied via R115 to N3 where further clipping takes place and a squarewave of 100 volts amplitude appears across N3, this is applied to the CAL.1. volt connector on the front panel via the network R110 R111 and R112. R112 is made variable to set the amplitude of the voltage at the Calibration Post to exactly 1 volt. The Capacitor C42 removes some of the overshoot on the squarewave which is due to the difference between the striking and burning potentials of the gas diodes. Some overshoot is left on the squarewave in order to provide a sharp pulse to facilitate setting the Time Calibration.

POWER SUPPLY

The Rectifier tube V10 supplies the various B+ voltages via the smoothing resistors R115, R116, R117, R118, R119, R123.

The high voltage supply for the CR tube is derived from the secondary of the power transformer via the MULTIPLIER circuit MR1 MR2 and MR3, these are tubular metal rectifiers of the selenium type. MR1 also provides the negative supply for the sweep generator via R120 and C50. The positive pulse which appears at the screen of V7a in the sweep generator is applied to the grid of the CR tube as unblanking via the network C53 R126 & C57 R132. The D.C. level is thus preserved and C57 is adjustable for high frequency compensation. Intensity modulation signals can be applied to the cathode of the CR tube via C56.

COMPENSATION AGAINST LINE VOLTAGE VARIATIONS

No form of stabilisation is used in the power supplies for the D31/D31R but a high degree of compensation for line voltage variations is achieved in the following way:-

The deflection sensitivity of the CR tube is inversely proportional to its final anode voltage and this varies in proportion to the AC input voltage. The vertical Amplifier has been arranged so that its GAIN varies in proportion to the B+ voltage. If the A.C. input voltage rises the resulting increase in GAIN of the vertical Amplifier and decrease in sensitivity of the CR tube cancel out. At the minimum setting of the horizontal GAIN control (that is in the condition in which the sweep is calibrated) the heavy degenerative feed-back in the cathode circuits of the horizontal output valves V8a and V9a keeps the GAIN of this stage independent of the B+ voltage. In the sweep generator itself both the amplitude sweep voltage and the sweep speed in volts per micro-second vary as a direct function of the supply voltage. Obviously with the inversely varying sensitivity of the CR tube the trace on the screen will remain the same length and have the same speed in CM per usecs. In practice this compensation works extremely well and the calibration of the D31/D31R remains constant for widely varying input voltages.

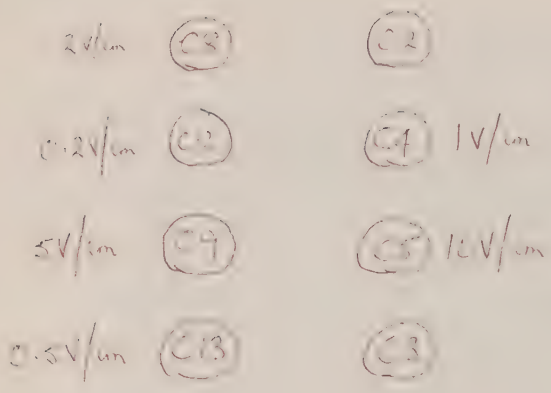
MAINTENANCE ADJUSTMENTS

The simplicity of the circuitary of the D31/D31R makes it an extremely reliable instrument and for the most part servicing will be limited to the replacement of defective tubes. When replacing tubes in the vertical Amplifier you may find that you will have to select pairs of tubes of approximately the same characteristics in order to get the vertical SHIFT to operate symmetrically about the centre of the screen. Apart from this, replacements of tubes in the vertical Amplifier will have very little effect on its performance and no readjustment should be necessary. In the sweep generator and Horizontal Amplifier the tubes are not particularly critical and you will find that you can replace these without having to alter the internal adjustments. If for any reason the internal pre-set controls do require adjustment the following detailed instructions will allow you to do this quickly and accurately.

ADJUSTMENT PROCEDURE

INPUT ATTENUATOR

In order to adjust the input attenuator compensation you will need a squarewave generator with a frequency of approximately 2 KCs and whose output can be varied between .2 volts and 100 volts. The rise time of the squarewave need not be particularly fast but it must have a good flat top and bottom. Connect the squarewave generator to the input socket and adjust the output to approximately .2 volt. Set the input attenuator to .1 volt per cm. and adjust the sweep controls so that you are displaying 3 cycles of the squarewave. Now carry out the following procedure step by step adjusting each trimmer to give a square corner to the squarewave. On each setting of the input attenuator you should adjust the output of the squarewave generator to give a trace of approximately 2 - 3 cm. amplitude.


2 V/cm
C8
C2
0·2 V/cm
C12
C4
1 V/cm
5 V/cm
C9
C5
1·2 V/cm
0·5 V/cm
C13
C3

Set Input Attenuator to:	Adjust
.2 volts per cm.	C12.
.5 " " "	C13.
1 " " "	C4
2 " " "	C8
5 " " "	C9
10 " " "	C5

If you have carried out these adjustments correctly the 20 volts per cm. and the 50 volts per cm. ranges are automatically correct. In order to adjust the capacitors C2 and C3 it is necessary to use the high impedance probe as these two capacitors only affect compensation when this probe is in use. Remove the squarewave generator from the input socket and plug in the high impedance probe, connect the output of the squarewave generator to the probe tip and set the input attenuator to .1 volt per cm., set the output of the squarewave generator to give approximately 2 cm. amplitude and adjust the probe trimmer (this is accessible through the hole in the probe body) to give a flat top to the squarewave. Now switch the input attenuator to the 1 volt per cm. range, re-adjust the output of the squarewave generator and adjust C2, set the input attenuator to the 10 volts per cm. range and adjust C3. All other ranges will automatically be correct.

VERTICAL AMPLIFIER

Adjustment of the high frequency compensation of the vertical Amplifier should only be carried out if you have at your disposal a squarewave generator which is capable of producing an accurate squarewave at a frequency of about 250 KCs with a rise time less than 40 milli-seconds and which is known to be absolutely free from ring or overshoot. The compensation circuits in the vertical Amplifier are extremely stable and unless such a generator is available you would be wise not to attempt any readjustment.

Set the input attenuator switch to .1 volt per cm. and adjust the output of the squarewave generator to give a trace of approximately 2-3 cm. amplitude (the output frequency on the generator should be between 200 and 300 KCs). The variables L1 L3 L4 and C17 are to some extent interdependent and it may be necessary to adjust any

or all of these to obtain the desired result which is a flat topped squarewave with a fast rise time, square corners and no overshoot. L3 and L4 affect the extreme corners of the squarewave and should be adjusted so that they are approximately equal inductances. C17 has a longer time constant and should be set to give a flat top to the squarewave.

The only other adjustment on the vertical amplifier is the set GAIN control.

TRIGGER CIRCUIT

The only adjustment necessary in the TRIGGER circuit is an occasional setting of the TRIGGER sensitivity control R63. This should be set so that the TRIGGER circuit will operate when the trace amplitude on the screen exceeds 2 mm. If any attempt is made to increase the sensitivity beyond this point erratic operation will almost inevitably result. This adjustment can conveniently be made using the internal calibration signal. Join a connector between the CAL. output and the input and adjust the sweep controls so that you are displaying about 5 cycles of the calibration waveform. Now set the input attenuator to the 5 volts per cm. range (giving a trace 2 mm. high) and adjust the TRIGGER sensitivity control so that at a critical setting of the TRIG. LEVEL control the sweep will just trigger, now reduce the trace amplitude to 1 mm. and make sure that the sweep will not trigger on this signal.

SWEEP GENERATOR AND HORIZONTAL AMPLIFIER

To make a complete readjustment of the Sweep Generator and Horizontal Amplifier carry out the following procedure :

SET 'VARIABLE' TO CAL.

Set the TIME/CM switch to 100 usecs. and the MULTIPLIER Switch to 10, advance the STABILITY control until the Sweep just free runs. With the X-SHIFT control in its mid position and the X-GAIN control in the minimum position, adjust R82 until the trace length is approximately 7 cm. and adjust R98 to centre this trace about the 6 cm. marks on the graticule. Now advance the BRILLIANCE control until you can see the spot at the beginning of the trace and you will find that by adjusting C28 you will be able to make a small "tail" appear to one side of the spot or the other. The correct setting for

1 volt peak to peak = 0.3535 volts R.M.S.

C28 is the point at which this "tail" just disappears into the spot. Alternatively, C28 can be adjusted by displaying a signal of approximately 100 KCs and setting C28 for optimum linearity at the beginning of the trace, but the first method is more simple and is quite satisfactory. Now set the TIME/CM switch to 20 millisecond. Now display the calibration voltage waveform and set the "set speed" control so that 1 cycle of the calibration waveform occupies exactly 1 cm. (still with the X-GAIN control to its minimum position). Now set the TIME/CM switch to one usec. Inject an accurate 1 megacycle signal into the input and adjust the volts per cm. switch to give a trace approximately 2 cm. amplitude. Now adjust C32 so that each cycle of this 1 megacycle signal occupies 1 cm.

VOLTAGE CALIBRATOR

R112 in the voltage calibrator circuit is provided so that the output can be set to precisely 1 volt. This adjustment can only be made by comparing the output with a known accurate 1 volt peak to peak signal. R112 will normally require no adjustment, provided that if the gas diode N3 is replaced, one of a similar type is used (N1 and N2 have a negligible effect on the amplitude of the output waveform).

CRT CIRCUIT

There are two pre-set controls in each CRT circuit. R131 and R137 are pre-set BRILLIANCE controls and are adjusted so that with the front BRILLIANCE controls at their minimum position the trace just disappears. Due to ageing of the CR tube you will find that after the initial period of use it will be necessary to make a slight adjustment to this internal pre-set control. The other adjustment is the frequency compensation of the re-trace blanking circuit C57. Set the sweep speed to 20 usecs per cm. and remove the input signal so that you are simply displaying a trace. You will find that adjustment of C57 varies the BRILLIANCE of the first part of the trace and you should set this capacitor so that the trace is of uniform brightness along its length.

HIGH IMPEDANCE PROBE

The adjustment of the probe compensation is best carried out with a squarewave generator with an output frequency of approximately 1 KC. The compensation trimmer is accessible through the hole in the body of the probe and you should adjust this to give a square corner to the squarewave. If a squarewave generator is not readily available the probe can be compensated using an internal signal from the sweep generator in the following manner :

Set the sweep speed to 1 millisecond per cm. and set the input attenuator to the 20 volts per cm. position. Set the AC/DC switch to AC. Now apply the tip of the probe to the test point and adjust the probe compensating trimmer to give a level start to the trace, under compensation and over compensation conditions are shown in the following diagram.

COMPONENTS LIST

ABBREVIATIONS

Capacitors

MP	Moulded Paper
SM	Silver Mica
Cer.	Ceramic Tubular
Elec.	Electrolytic

Resistors

C	Carbon Composition
HSC	High Stability Carbon
WW	Wire Wound
PS	Preset Carbon (Internal Adjustment)

In the following component lists, no manufacturers' names have been included. When replacing components, locally available alternatives may be used if exact replacements are not to hand, provided the physical size is the same.

It is, however, preferable to use exact replacements whenever possible and these should be ordered direct from :

TELEQUIPMENT LIMITED
313 Chase Road,
Southgate,
LONDON, N.14.

Telephone: FOX Lane 1166

or our agents.

COMPONENTS LIST

Component No.	Value	Description		
R 1	900K	HSC	1%	$\frac{1}{4}$ watt
R 2	111K	HSC	1%	$\frac{1}{4}$ watt
R 3	990K	HSC	1%	$\frac{1}{4}$ watt
R 4	10.1K	HSC	1%	$\frac{1}{4}$ watt
R 5	18	C	10%	$\frac{1}{4}$ watt
R 6	500K	HSC	1%	$\frac{1}{4}$ watt
R 7	1M	HSC	1%	$\frac{1}{4}$ watt
R 8	800K	HSC	1%	$\frac{1}{4}$ watt
R 9	250K	HSC	1%	$\frac{1}{4}$ watt
R 10	1M	HSC	1%	$\frac{1}{4}$ watt
R 11	100K	C	10%	$\frac{1}{4}$ watt
R 12	82	C	10%	$\frac{1}{4}$ watt
R 13	2.2K	C	10%	$\frac{1}{4}$ watt
R 14	2.2K	C	10%	$\frac{1}{4}$ watt
R 15	100	C	10%	$\frac{1}{4}$ watt
R 16	180	C	10%	$\frac{1}{4}$ watt
R 17	22K	C	10%	$\frac{1}{4}$ watt
R 18	22K	C	10%	$\frac{1}{4}$ watt
R 19	100K	Carbon Potentionmeter Y Shift		
R 20	100	C	10%	$\frac{1}{4}$ watt
R 21	100	C	10%	$\frac{1}{4}$ watt
R 22	100	C	10%	$\frac{1}{4}$ watt
R 23	100	C	10%	$\frac{1}{4}$ watt
R 24	27K	C	10%	$\frac{1}{2}$ watt
R 25	27K	C	10%	$\frac{1}{2}$ watt
R 26	100	C	10%	$\frac{1}{4}$ watt
R 27	100	C	10%	$\frac{1}{4}$ watt
R 28	1K	Carbon Potentionmeter 'Set Y Gain'		
R 29	100	C	10%	$\frac{1}{4}$ watt
R 30	10K	WW	5%	3 watt
R 31	10K	WW	5%	3 watt
R 32	6.8K	C	5%	1 watt
R 33	6.8K	C	5%	1 watt
R 34	100	C	10%	$\frac{1}{4}$ watt
R 35	100	C	10%	$\frac{1}{4}$ watt
R 36	100	C	10%	$\frac{1}{4}$ watt
R 37	100	C	10%	$\frac{1}{4}$ watt

Component No.	Value	Description		
R 38	10K	WW	5%	3 watt
R 39	10K	WW	5%	3 watt
R 40	4.7K	WW	5%	3 watt
R 41	4.7K	C	10%	$\frac{1}{4}$ watt
R 42	560	C	10%	$\frac{1}{4}$ watt
R 43	560	C	10%	$\frac{1}{4}$ watt
R 44	1.2M	C	10%	$\frac{1}{4}$ watt
R 45	470	C	10%	$\frac{1}{4}$ watt
R 46	4.7K	C	10%	$\frac{1}{4}$ watt
R 47	4.7K	C	10%	$\frac{1}{4}$ watt
R 48	1.2M	C	10%	$\frac{1}{4}$ watt
R 49	1.2M	C	10%	$\frac{1}{4}$ watt
R 50	6.8K	C	10%	$\frac{1}{4}$ watt
R 51	15K	WW	5%	3 watt
R 52	22K	C	10%	$\frac{1}{4}$ watt
R 53	68K	C	10%	$\frac{1}{4}$ watt
R 54	100K	C	10%	$\frac{1}{4}$ watt
R 55	56K	C	10%	$\frac{1}{4}$ watt
R 56	56K	C	10%	$\frac{1}{4}$ watt
R 57	100	C	10%	$\frac{1}{4}$ watt
R 58	560K	C	10%	$\frac{1}{4}$ watt
R 59	3.3K	C	10%	$\frac{1}{4}$ watt
R 60	10K	C	10%	1 watt
R 61	56K	C	10%	$\frac{1}{4}$ watt
R 62	2.7K	C	10%	$\frac{1}{4}$ watt
R 63	1M	PS	VAR.	$\frac{1}{4}$ watt
R 64	68K	C	10%	$\frac{1}{4}$ watt
R 65	100K	Carbon Potentionmeter Set Speed		
R 66	50K	Carbon Potentionmeter T/CM Variable		
R 67	22K	C	10%	$\frac{1}{4}$ watt
R 68	27K	C	10%	1 watt
R 69	470K	C	10%	$\frac{1}{4}$ watt
R 70	560K	C	10%	$\frac{1}{4}$ watt
R 71	100K	C	10%	1 watt
R 72	4.7K	C	10%	$\frac{1}{4}$ watt
R 73	100K	C	10%	2 watt
R 74	4.7M	C	10%	$\frac{1}{4}$ watt
R 75	39K	C	10%	2 watt
R 76	820K	C	10%	$\frac{1}{4}$ watt

Component No.	Value	Description		
R 77	560K	C	10%	$\frac{1}{4}$ watt
R 78	39K	C	10%	1 watt
R 79	1M	Carbon Potentionmeter 'Stability'		
R 80	100K	C	10%	2 watt
R 81	4.7K	C	10%	$\frac{1}{4}$ watt
R 82	560K	C	10%	$\frac{1}{4}$ watt
R 83	1M	PS		$\frac{1}{4}$ watt
R 84	220K	C	10%	$\frac{1}{4}$ watt
R 85	100K	Carbon Potentionmeter X Shift		
R 86	560K	C	10%	$\frac{1}{4}$ watt
R 87	56K	C	10%	1 watt
R 88	5K	PS	10%	$\frac{1}{4}$ watt
R 89	4.7K	C	10%	$\frac{1}{4}$ watt
R 90	2.2K	C	10%	$\frac{1}{4}$ watt
R 91	56K	C	10%	1 watt
R 92	10K	Carbon Potentionmeter X Gain Inverse Log		
R 93	4.7K	C	10%	$\frac{1}{4}$ watt
R 94	56K	C	10%	1 watt
R 95	5K	PS	10%	$\frac{1}{4}$ watt
R 96	56K	C	10%	1 watt
R 97	560K	C	10%	$\frac{1}{4}$ watt
R 98	1M	PS	X Shift	
R 99	4.7K	WW	5%	3 watt
R100	1.2M	C	10%	$\frac{1}{4}$ watt
R101	350K	HSC	1%	$\frac{1}{4}$ watt
R102	400K	HSC	1%	$\frac{1}{4}$ watt
R103	1.2M	HSC	1%	$\frac{1}{4}$ watt
R104	2 M	HSC	1%	$\frac{1}{4}$ watt
R105	4 M	HSC	1%	$\frac{1}{4}$ watt
R106	12 M	HSC	1%	$\frac{1}{4}$ watt
R107	2.2M	C	10%	$\frac{1}{4}$ watt
R108	560K	C	10%	$\frac{1}{4}$ watt
R109	560K	C	10%	$\frac{1}{4}$ watt
R110	2 M	HSC	1%	$\frac{1}{4}$ watt
R111	18K	HSC	1%	$\frac{1}{4}$ watt
R112	5K	PS	1 volt Cal.	
R113	39	WW	10%	2 watt
R114	39	WW	10%	2 watt

Component No.	Value	Description		
R115	12K	WW	10%	5 watt
R116	5K	WW	10%	7.5 watt
R117	500K	WW	10%	3 watt
R118	5K	WW	10%	7.5 watt
R119	500K	WW	10%	3 watt
R120	10K	C	10%	$\frac{1}{4}$ watt
R121	27K	C	10%	$\frac{1}{4}$ watt
R122	220K	C	10%	$\frac{1}{4}$ watt
R123	2.2M	C	10%	$\frac{1}{4}$ watt
R124	27K	C	10%	$\frac{1}{4}$ watt
R125	1M	Carbon Potentiometer "Astig"		
R126	6.8M	C	10%	$\frac{1}{4}$ watt
R127	1M	Carbon Potentiometer "Focus"		
R128	560K	C	10%	$\frac{1}{4}$ watt
R129	200K	Carbon Potentiometer "Brilliance"		
R130	56K	C	10%	$\frac{1}{4}$ watt
R131	1M	PS	10%	$\frac{1}{4}$ watt
R132	560K	C	10%	$\frac{1}{4}$ watt
R133	10K	C	10%	$\frac{1}{4}$ watt
R134	200K	Carbon Potentiometer "Brilliance"		
R135	56K	C	10%	$\frac{1}{4}$ watt
R136	1M	PS	10%	$\frac{1}{4}$ watt
R137	560K	C	10%	$\frac{1}{4}$ watt
R138	1M	Carbon Poteniometer "Focus"		
R139	2.2M	C	10%	$\frac{1}{4}$ watt

Component No.	Value	Description	
C 1	.1uf	MP	20%
C 2	3.30	Trimmer	
C 3	3.30	Trimmer	
C 4	3.30	Trimmer	
C 5	3.30	Trimmer	
C 6	100 pf	SM	20%
C 7	.001	SM	20%
C 8	3.30	Trimmer	
C 9	3.30	Trimmer	
C 10	39 pf	Cer.	20%
C 11	20 pf	Cer.	20%
C 12	3.30	Trimmer	
C 13	3.30	Trimmer	
C 14	30 pf	Cer.	20%
C 15	15 pf	Cer.	20%
C 16	.01 uf	MP	20%
C 17	450 pf	Trimmer	
C 18	32 uf	ELEC.	350 V
C 19	.1 uf	MP	20%
C 20	.1 uf	MP	20%
C 21	.1 uf	MP	20%
C 22	.01 uf	MP	20%
C 23	32 uf	Elec.	350 V
C 24	.1 uf	MP	20%
C 25	30 pf	Cer.	20%
C 26	100 pf	Cer.	20%
C 27	30 pf	Cer.	20%
C 28	450 pf	Trimmer	
C 29	.25 uf	MP	20%
C 30	.1 uf	MP	20%
C 31	32 uf	Elec.	350 V
C 32	3.30 pf	Trimmer	
C 33	39 pf	Cer.	20%
C 34	180 pf	SM	5%
C 35	100 pf	Cer.	20%
C 36	.002 uf	MP	5%
C 37	.001 uf	MP	20%
C 38	.02 uf	MP	5%
C 39	.01 uf	MP	20%

Component No.	Value	Description		
C 40	.2 uf	MP		5%
C 41	.1 uf	MP		20%
C 42	.005 uf	MP		10%
C 43	32 uf	Elec.		450 V
C 44	.1 uf	900 V DC. 475 AC		15%
C 45	32 uf	Elec.		350 V
C 46	32 uf	Elec.		350 V
C 47	32 uf	Elec.	450 V	
C 48	32 uf	Elec.	350 V	
C 49	32 uf	Elec.	450 V	
C 50	8 uf	Elec.	450 V	
C 51	.5 uf	P.	1500 V	20%
C 52	.5 uf	P.	1500 V	20%
C 53	30 pf	Cer.	1500 V	20%
C 54	.5 uf	P.	1500 V	20%
C 55	.1 uf	MP	1500 V	20%
C 56	.01 uf	MP		20%
C 57	450 pf	Trimmer		
C 58	.1 uf	MP		20%

Component No.	Description
L1	Variable Iron Cored Inductance
L2	Fixed Iron Cored Inductance
L3	Variable Iron Cored Inductance
L4	Variable Iron Cored Inductance
L5	Fixed Iron Cored Inductance
L6	Fixed Iron Cored Inductance
N1	Neon Voltage Reference Tube Type NT2.50v
N2	Neon Voltage Reference Tube Type NT2.50v
N3	Neon Voltage Reference Tube Type NT2.50v
MR1	K8/20 Selenium Rectifier
MR2	K8/35 Selenium Rectifier
MR3	K8/20 Selenium Rectifier
CR1	Crystal Diode Type GD5
T1	Power Transformer Type 450-375v-0-375v @ 170mA 5v @ 2 amps 6.3v @ .6 amps 6.3v @ 1 amp

TUBES

V1A	½ ECF 80
V1B	½ ECF 80
V2A	½ ECF 80
V2B	½ ECF 80
V3A	½ ECF 80
V3B	½ ECF 80
V4A	½ ECF 80
V4B	½ ECF 80
V5A	½ ECF 80
V5B	½ ECF 80
V6A	½ ECF 80
V6B	½ ECF 80
V7A	½ ECF 80
V7B	½ ECF 80
V8A	½ ECF 80
V8B	½ ECF 80
V9A	½ ECF 80
V9B	½ ECF 80
V10	5 V4G
V11A	½ ECF 80
V11B	½ ECF 80
V12A	½ ECF 80
V12B	½ ECF 80
V13A	½ ECF 80
V13B	½ ECF 80
V14A	½ ECF 80
V14B	½ ECF 80

GRT ETGL TYPE 3 AZ P31

VOLTAGES FOR D31 AND D31R

Tube	Anode V	Screen Grid V	Control Grid V	Cathode V	
V1A & V11A	100	100	0	1.5	Avo Meter on 10V range
V1B & V11B	260	-	100	104	
V2A & V12A	100	100	0	1.5	Avo Meter on 10V range
V2B & V12B	260	-	100	104	
V3A & V13A	200	250	104	105	
V3B & V13B	390	-	200	210	
V4A & V14A	200	250	104	105	
V4B & V14B	390	-	200	210	
V5A	230	35	0	0	
V5B	190	-	40	50	
V6A	220	230	100	106	
V6B	210	-	100	106	
V7A	160	170	0	0	
V7B	70	-	70	225	
V8A	230	225	45	50	
V8B	380	-	60	150	
V9A	240	225	50	55	
V9B	60	-	-10	0	
V10A & B	375	-	-	420	

C.R.T. Both Guns	Anode 1 & 3	Anode 2	Grid	Cathode
	200V	-740	-1,200V	-1,140V

HT1 A & B	HT2 A & B	HT3	HT-1	H-2 & 3
400V	260V	225V	-410V	-1,250V

Measurements made with 'Avo' Model '8' on 1,000V range unless otherwise stated.
Measurements over 700 volts made on 2,500 volt range.
Measurements made with the absence of any 'Y' signal, and the stability advanced so that the time base just free runs.
The time/centimetre switch was set to 1 m.sec.

TUBE CHANGING DATA FOR D31 and D31R

It will be appreciated that there are inherent differences between any two tubes of the same type due to small variations in both X plate alignment and sensitivities. The following simple instructions will enable the instrument to be re-aligned to give the same "X" performance on each trace.

Remove the sides, front bezel and graticule of the D31.

Remove the tube base and side connectors from the tube.

Unscrew the two 2BA screws on either side of the support clamp at rear of the tube and remove clamp.

By gently pushing the front of the tube and supporting the tube in the other hand, it will now be possible to lift the tube out. Remove the outer mu metalshield, inner gun shield and rubber bands from the tube and replace on the new tube in identical manner. Replace the tube etc. in reverse to the above instructions; replace the clamp and screws, but do not tighten the screws. Switch the instrument on, and obtain two traces on the screen of the tube. It will now be found necessary to rotate the whole tube assembly until the traces are exactly horizontal, this can be checked against the graticule. Having done this, the screws on the support clamp may be tightened.

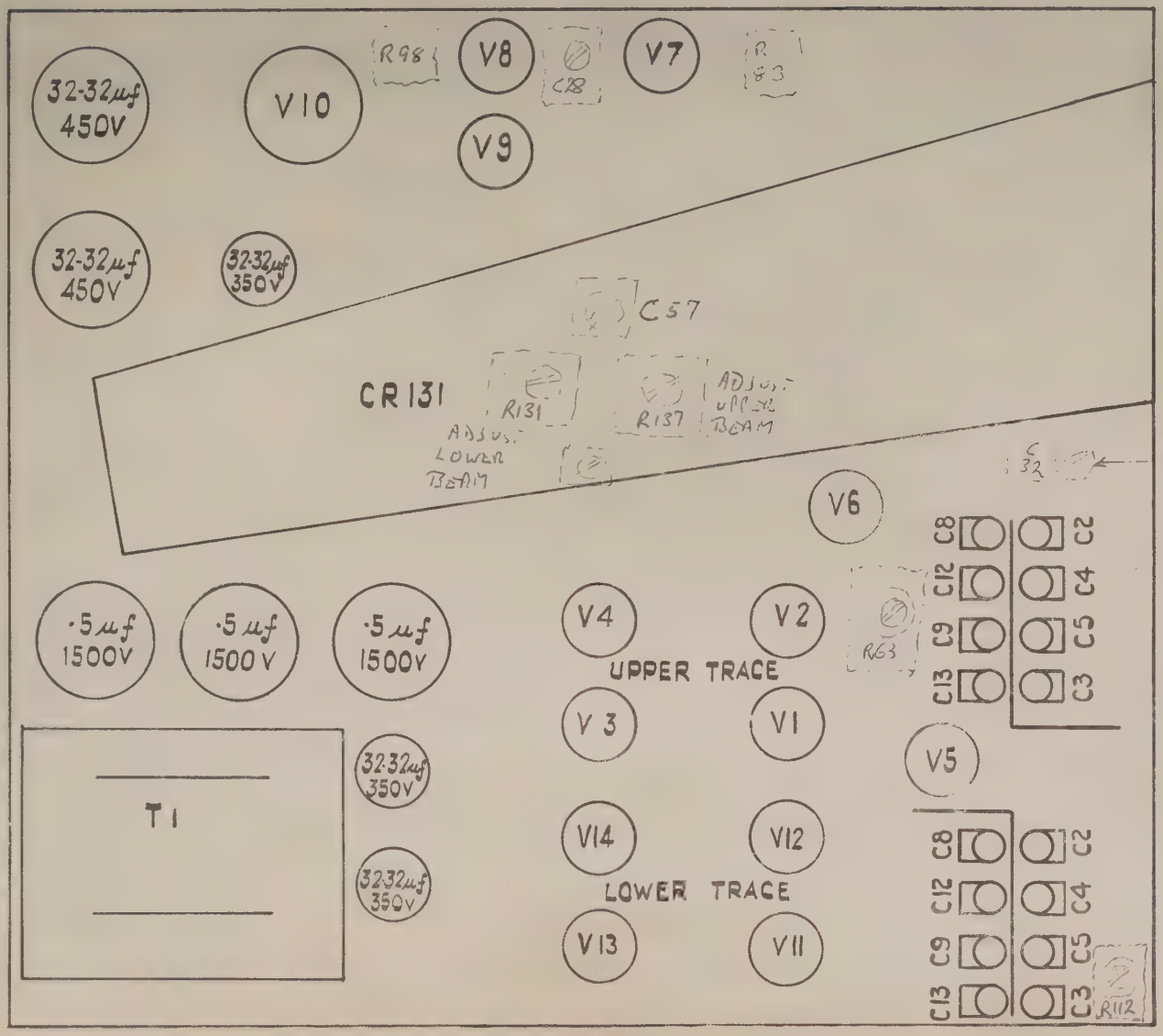
Set the time base speed to approximately 1 millisec. per centimetre, the traces approximately 1 mm apart in the centre of the tube and on examination it will almost certainly be noticed that the trace lengths are either not of the same length or not in the same position on the X axis, or a combination of both.

The relative positions and trace lengths are adjusted by the preset potentiometers R88. R95 in the anode circuits of the X Amplifier output tubes. The potentiometers are adjusted simultaneously, the trace lengths being altered by turning both controls in the same direction, the position of each trace is altered by rotating the controls in opposite directions.

Next set the time base speed at 1 millisec. per centimetre and adjust R83 (1 M.ohm) for a trace length of 6 cms excluding the spot at the beginning of the trace. Finally adjust trimmer C28 (450 pf) so that the spot at the beginning of the trace is not elongated, i.e. has no "tail" on it. Replace the sides, graticule and appropriate filter and instrument is ready for use.

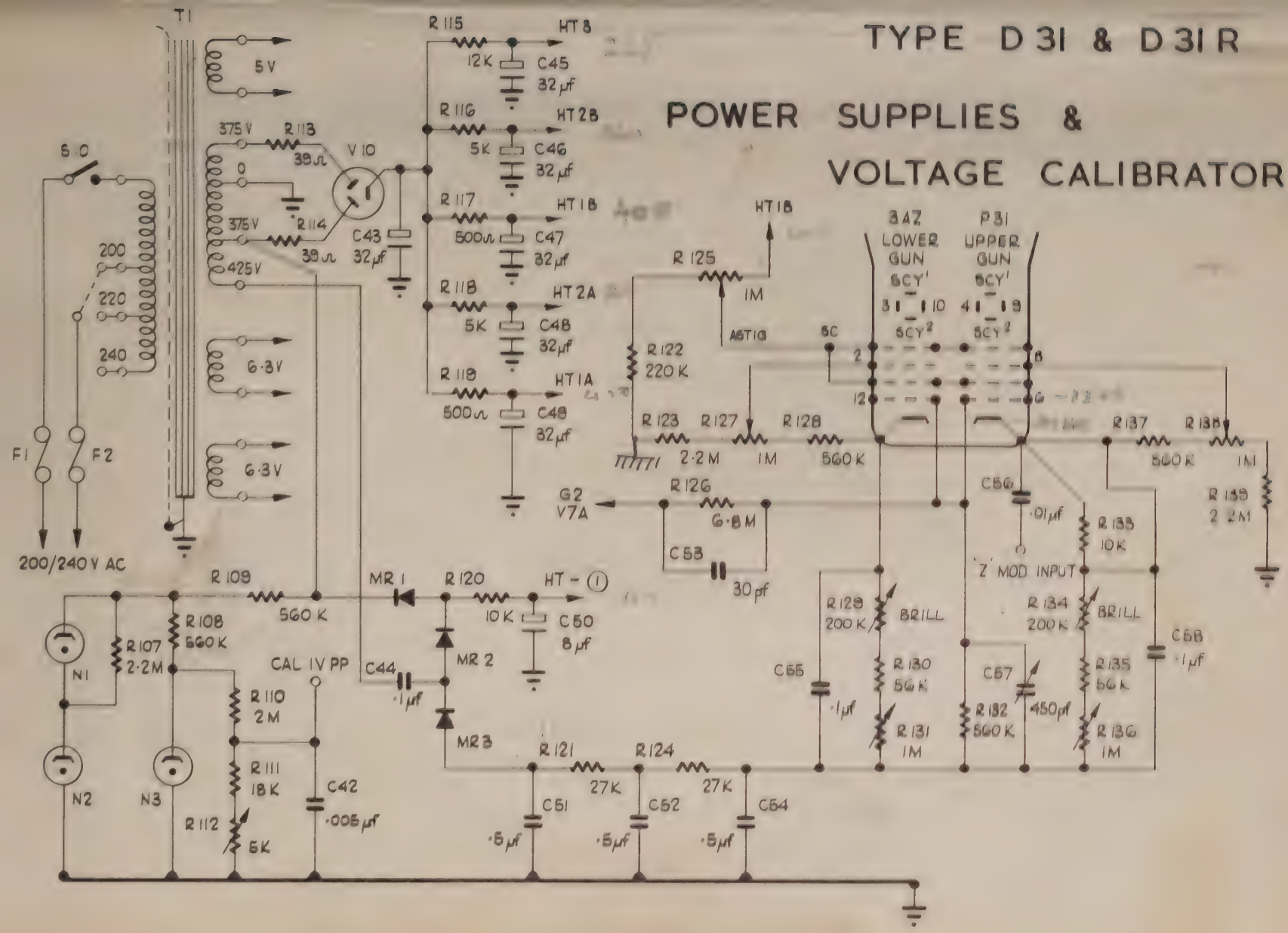
VALVE LAYOUT DIAGRAM

TYPE D 31



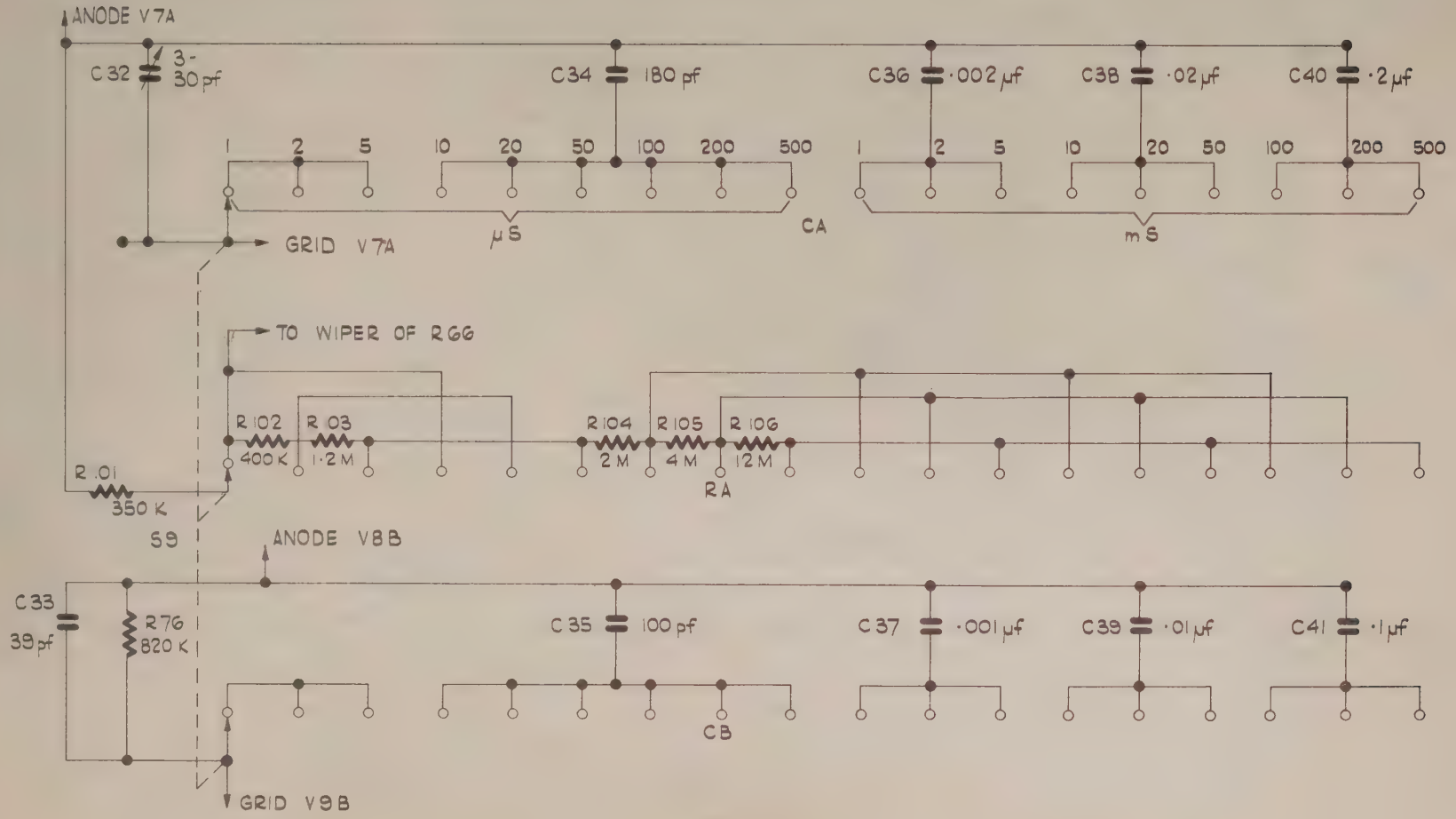
TYPE D31 & D31R

POWER SUPPLIES & VOLTAGE CALIBRATOR

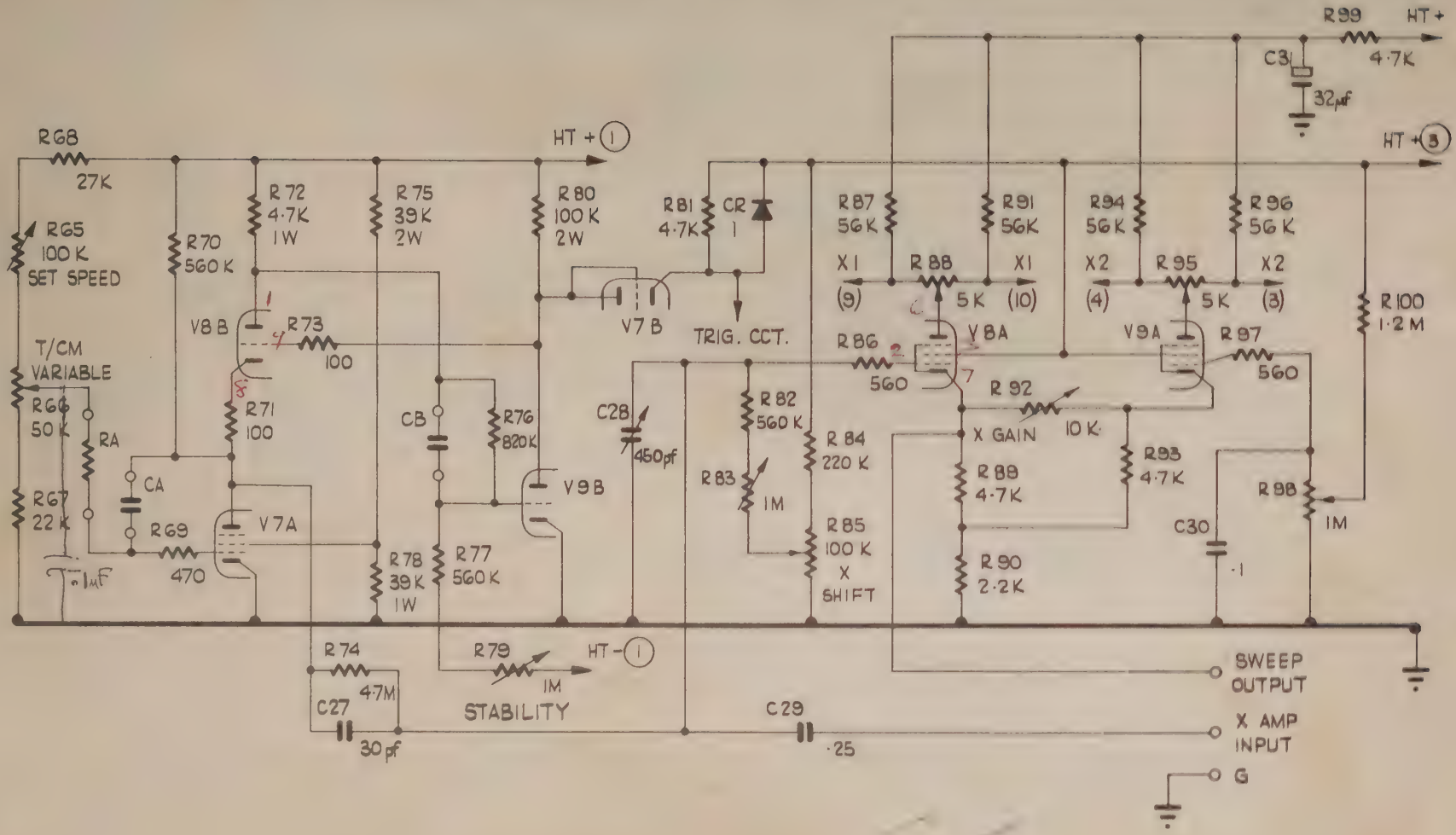


TIME BASE SWITCH

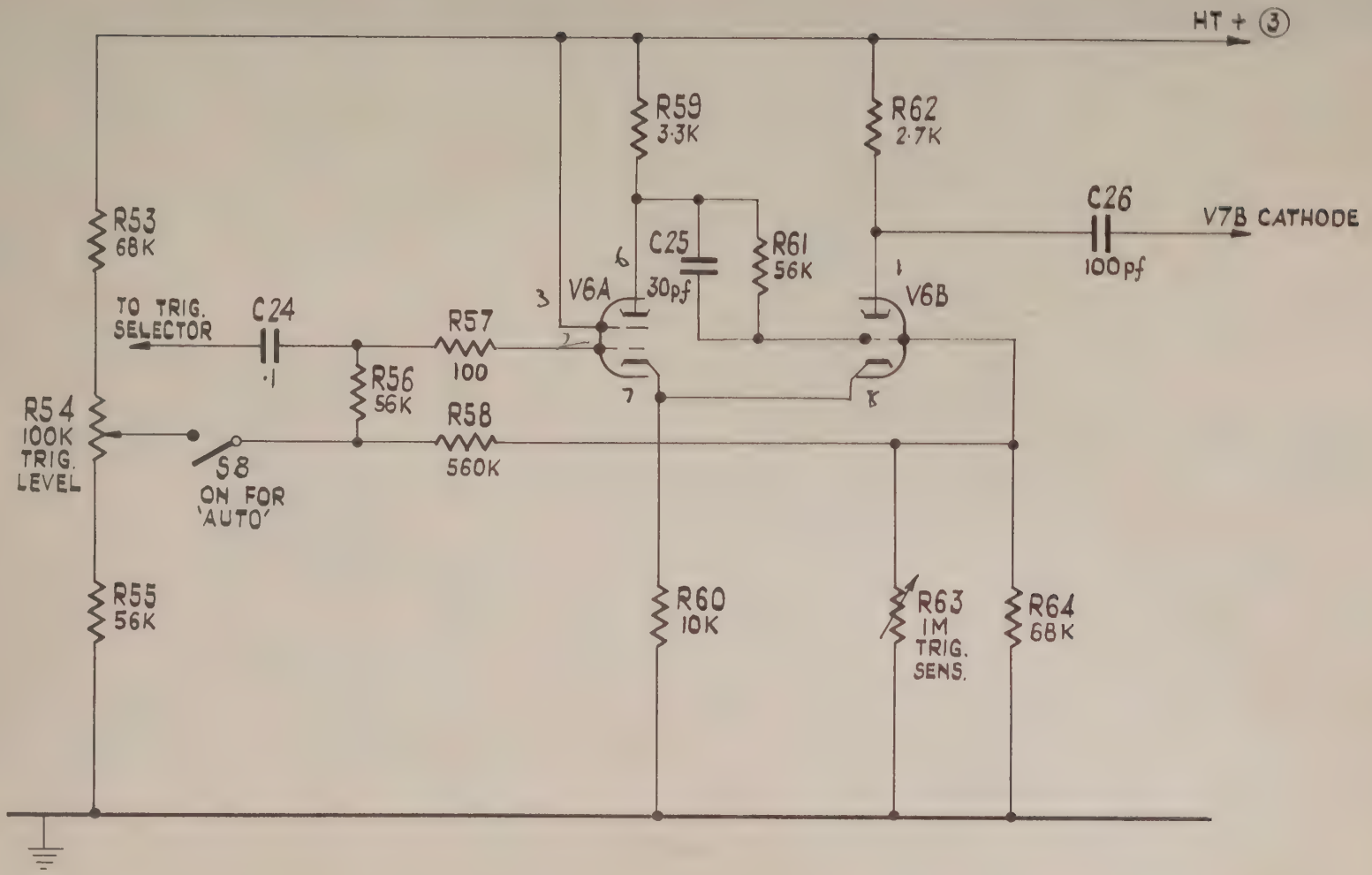
TYPE D31 & D31R



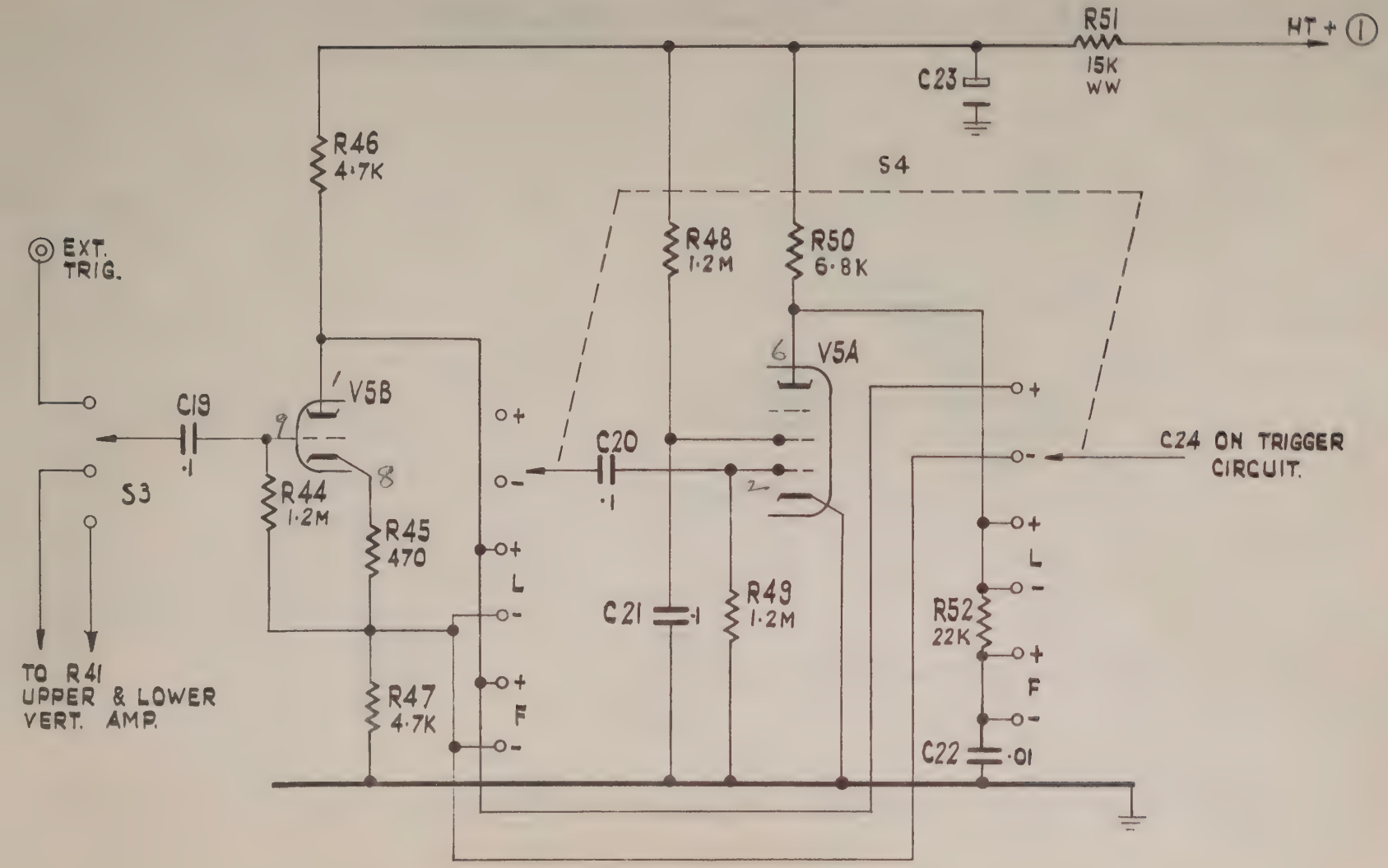
TIME BASE & HORIZ. AMP.



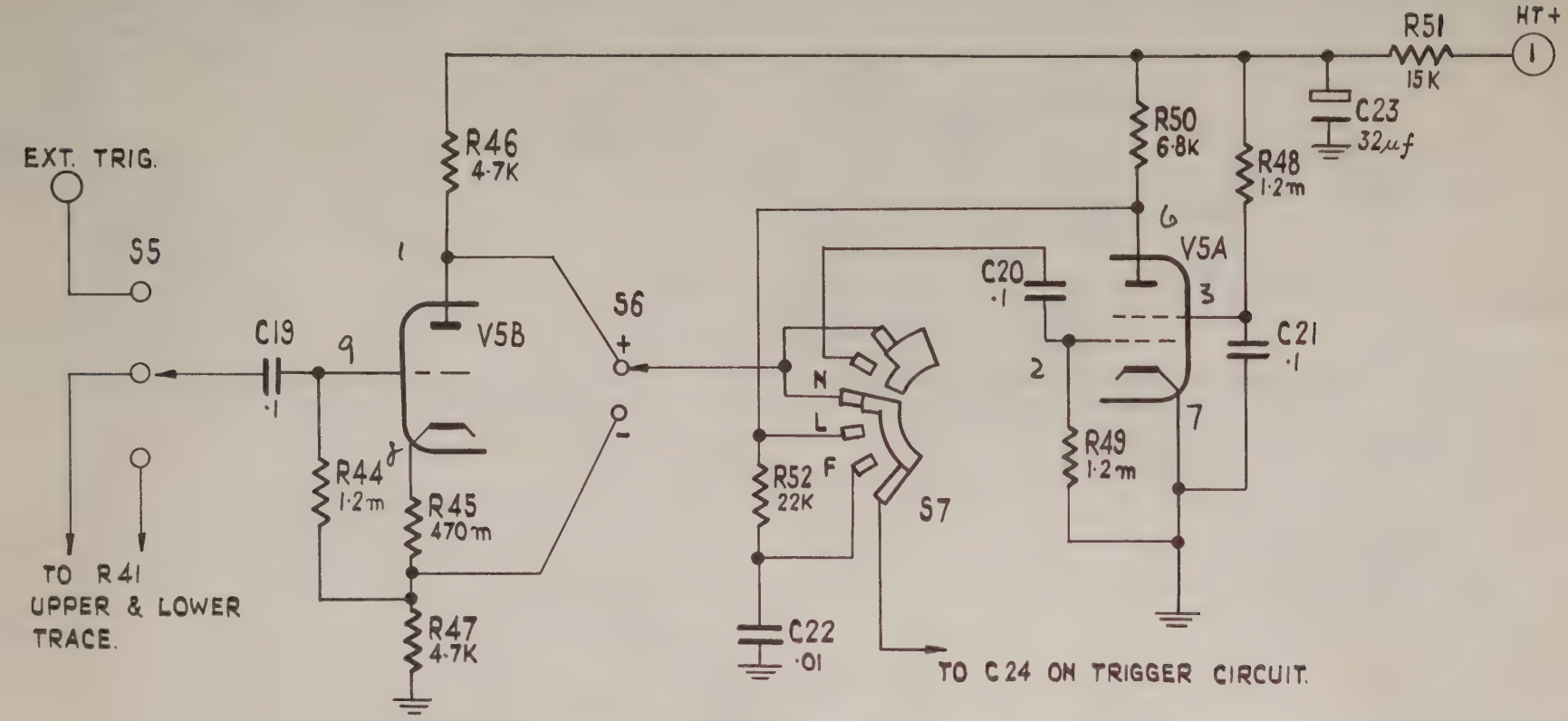
TRIGGER CIRCUIT TYPE D31 & D31R



TRIGGER SELECTION



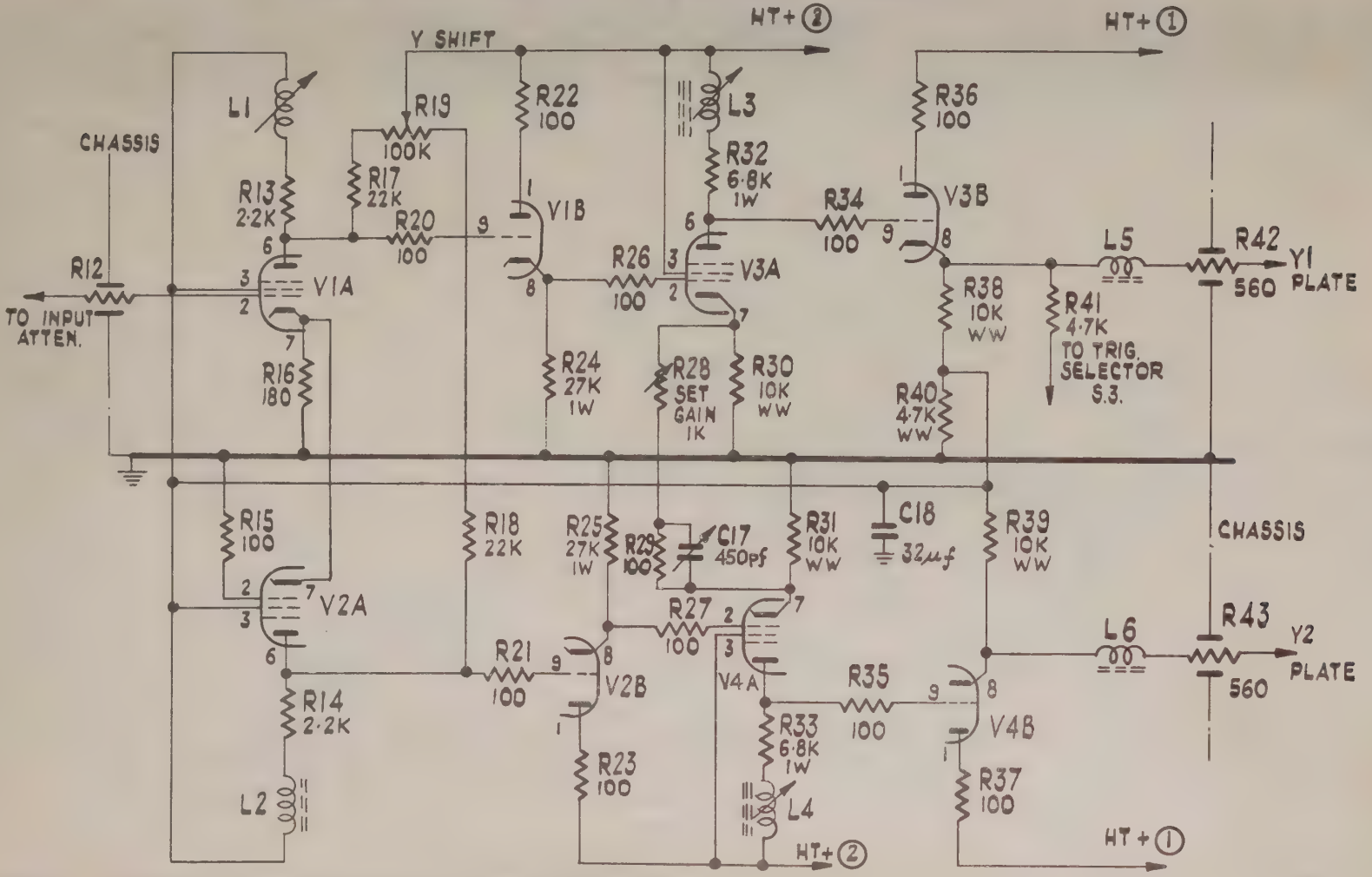
TRIGGER SELECTION



SWITCHES SHOWN IN 'NORMAL + VE' POSITION

VERTICAL AMPLIFIERS

IDENTICAL FOR UPPER & LOWER TRACES.

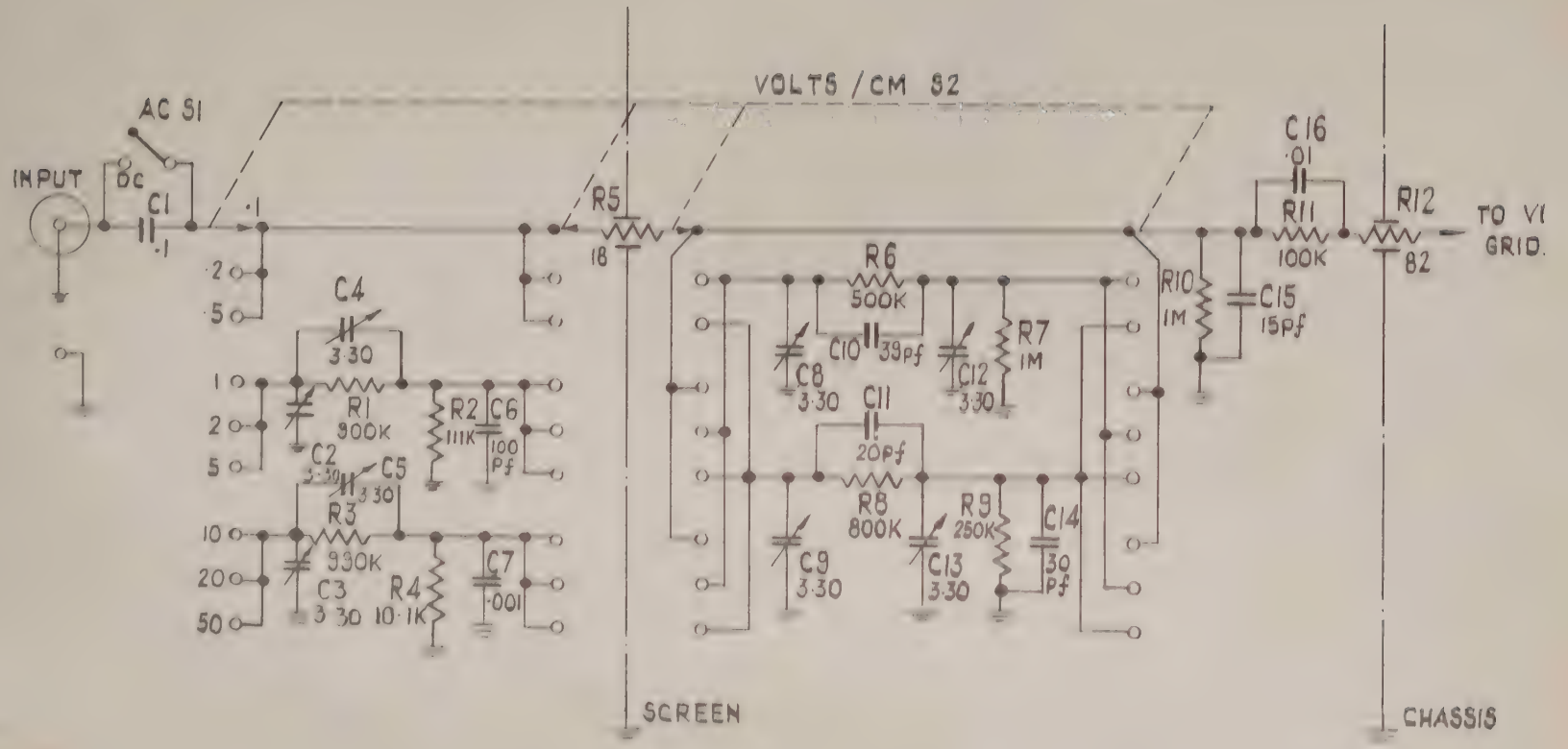


UPPER TRACE AMPLIFIER V_1 V_2 V_3 & V_4

LOWER " " V_{11} V_{12} V_{13} & V_{14}

INPUT ATTENUATORS

IDENTICAL FOR UPPER & LOWER TRACES



TYPE D 31 R

VALVE LAYOUT DIAGRAM